

# ***Salmonella* Enteritidis:** **Surveillance Data and Policy Implications**

**Alejandro Pérez, MPH**

**Enteric Diseases Epidemiology Branch  
Division of Foodborne, Bacterial and Mycotic Diseases  
National Center for Zoonotic, Vector-Borne, and Enteric Diseases  
Centers for Disease Control and Prevention**



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# Glossary of Terms

- *Salmonella* Enteritidis (SE) - the bacteria *Salmonella enterica* serotype Enteritidis
- Serotype - strain of *Salmonella* based on reaction with specific antibodies
- Salmonellosis - the disease caused by infection by *Salmonella enterica*
- Isolate - *Salmonella* bacterium obtained from a single laboratory culture

# *Salmonella*

- A genus of gram-negative, rod-shaped bacteria
- Live in intestines and peri-reproductive tissues (ovaries, milk glands, etc)
- Few species, but thousands of serotypes

# Salmonellosis

- Disease caused by infection with *Salmonella*
- Symptoms include diarrhea, fever, abdominal cramps
- Starts 12-72 hours after infection and lasts 4-7 days
- Severe cases can result in hospitalization and can infect the blood and lead to death
- Infants, the elderly, and immunocompromised are most at risk

# ***Salmonella Enteritidis* and eggs**

- Eggs identified as primary vehicle for SE infection
- Exterior of eggs contaminated by contact with feces
- Interior of eggs contaminated via transovarian transmission
- In 1990's it was estimated that 7% of egg farms had SE and 1 in 20,000 eggs were positive for SE

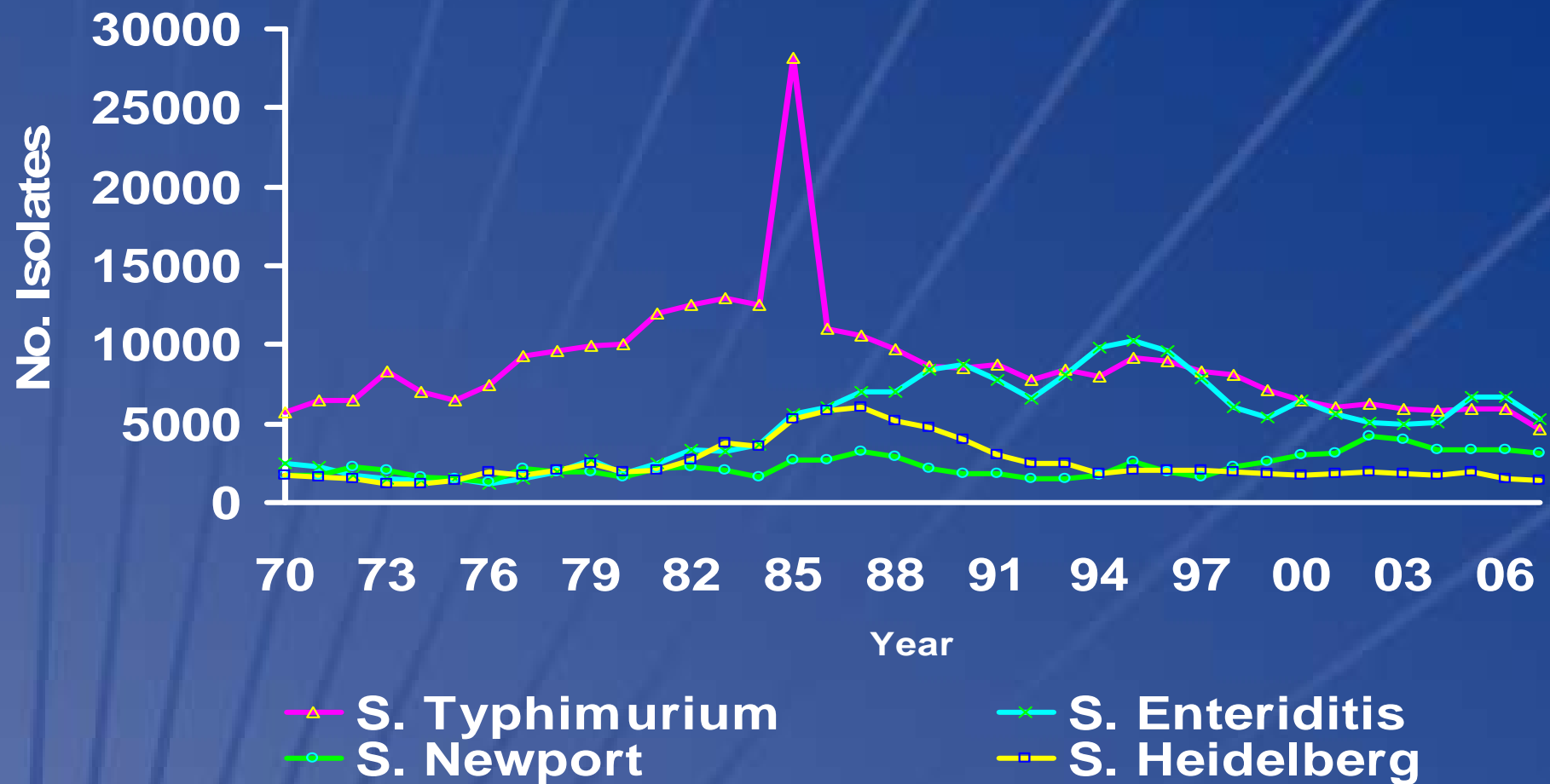
# **National *Salmonella* Surveillance**

- **Surveillance for individual patients**
  - **Salmonellosis is a nationally notifiable disease**
- **Surveillance for foodborne outbreaks**
  - **Two or more people ill due to a common food exposure**
  - **May be reported to or recognized by health departments**

# **National *Salmonella* Surveillance System**

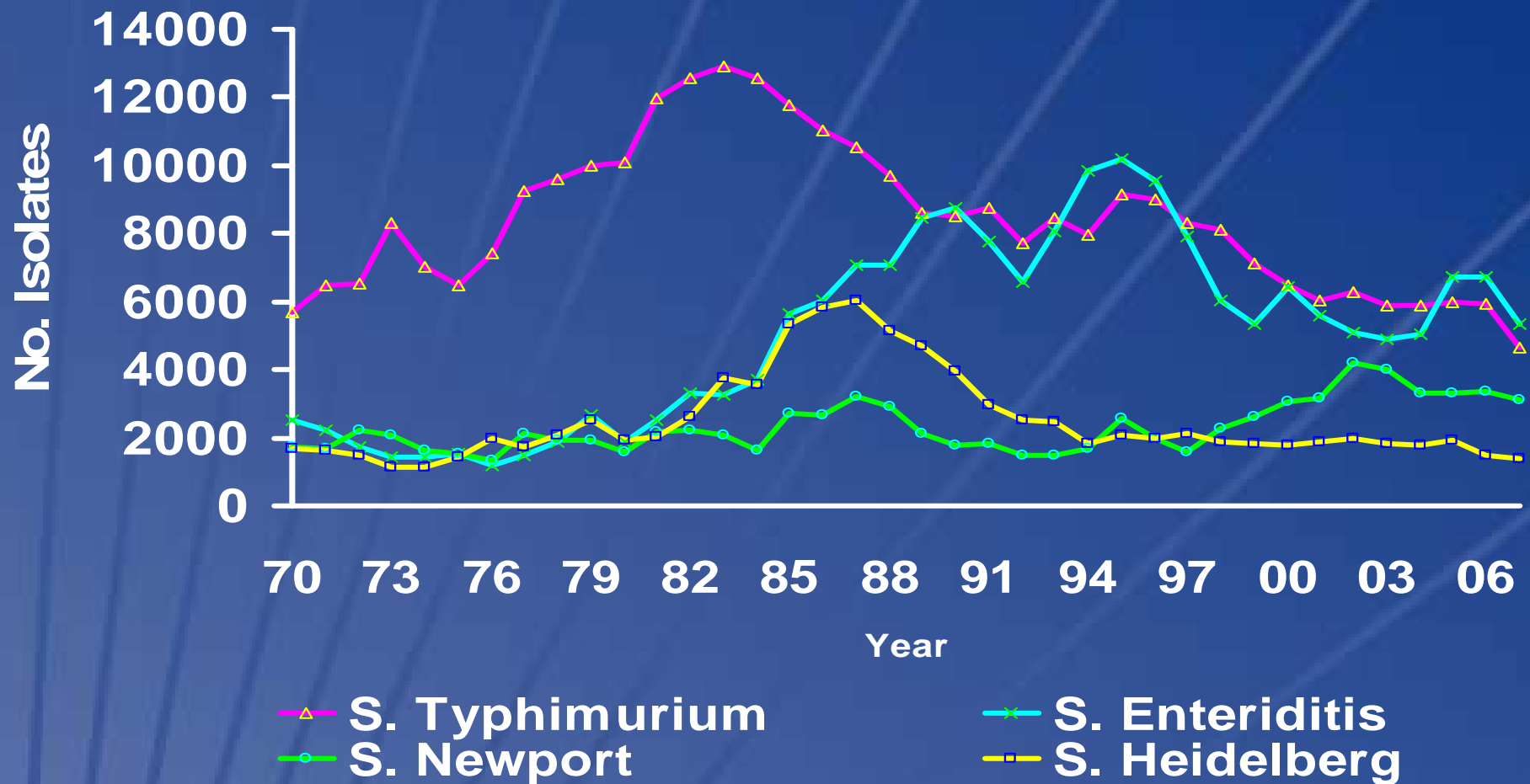
- **Established in 1970s**
- **Collects information on individual patients**
- **Public Health Laboratory Information System**
  - **Electronic reporting of isolate data by public health labs**
  - **Includes serotype information**
- **Passive surveillance**

# Top four *Salmonella* serotypes, 1970-2007





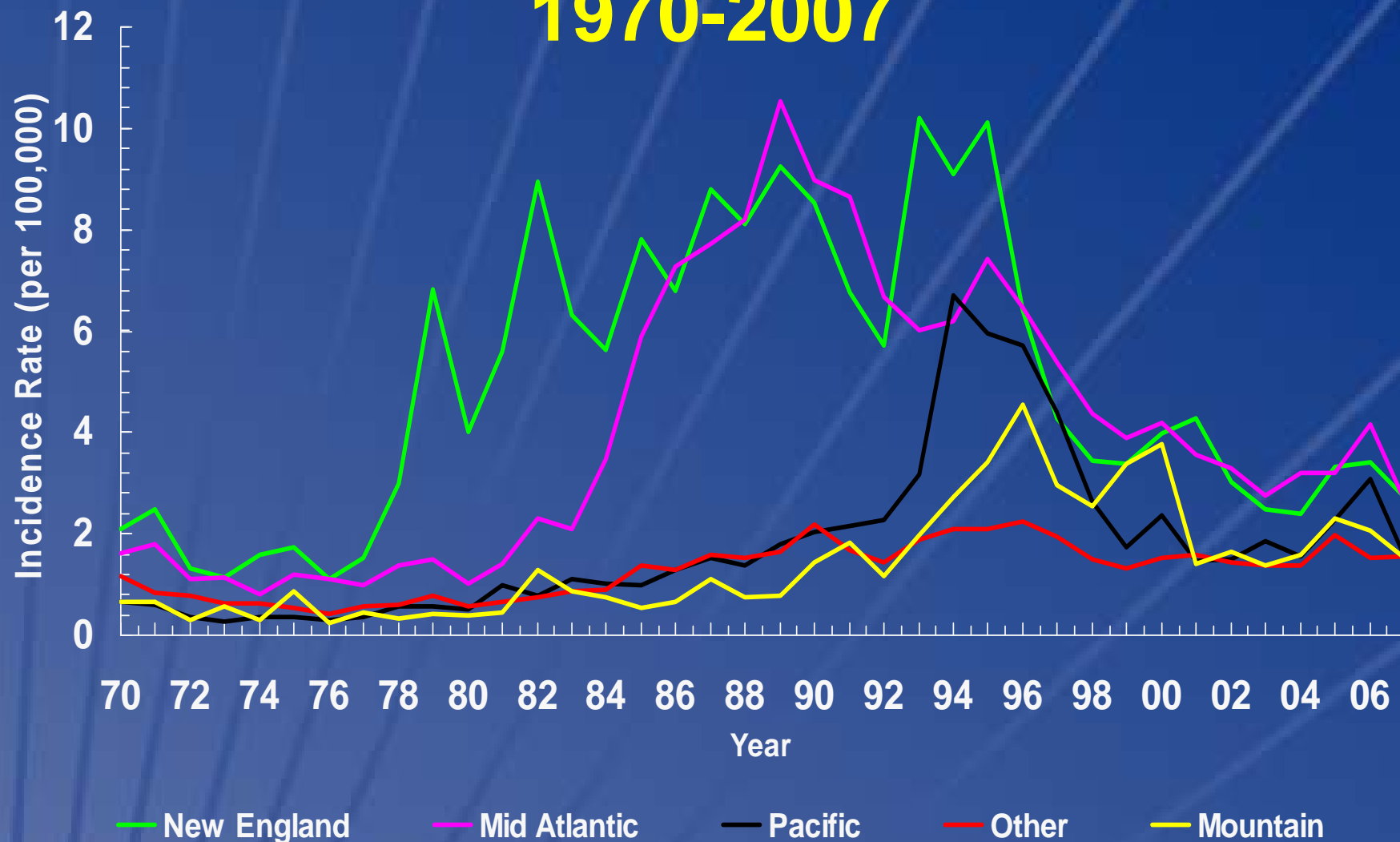
# Top four *Salmonella* serotypes, 1970-2007



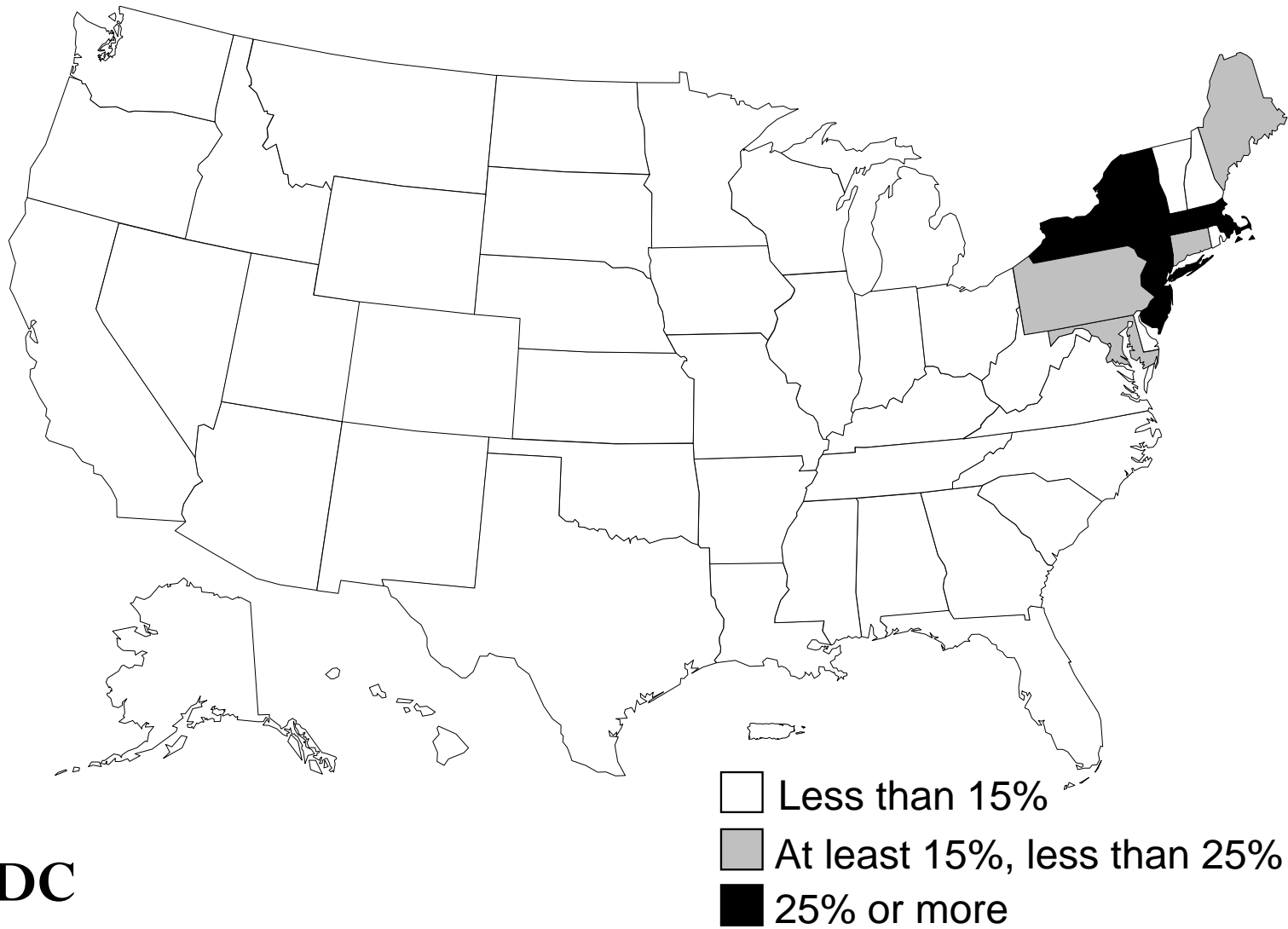
# SE isolations, 1989-2007



# SE rates by region, 1970-2007

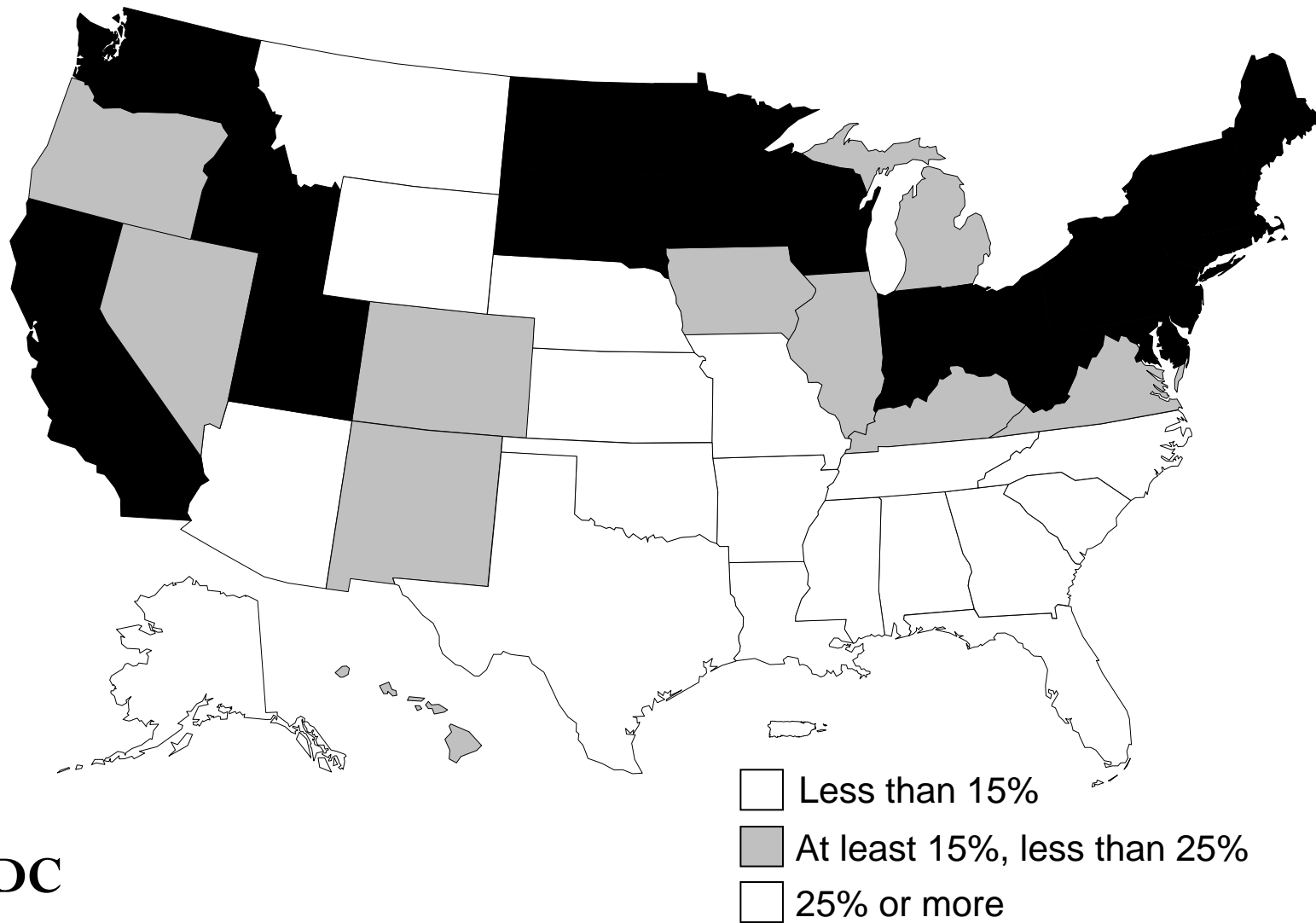


## Percent of *Salmonella* that is *Salmonella* Enteritidis - 1985



CDC

## Percent of *Salmonella* that is *Salmonella* Enteritidis - 1994



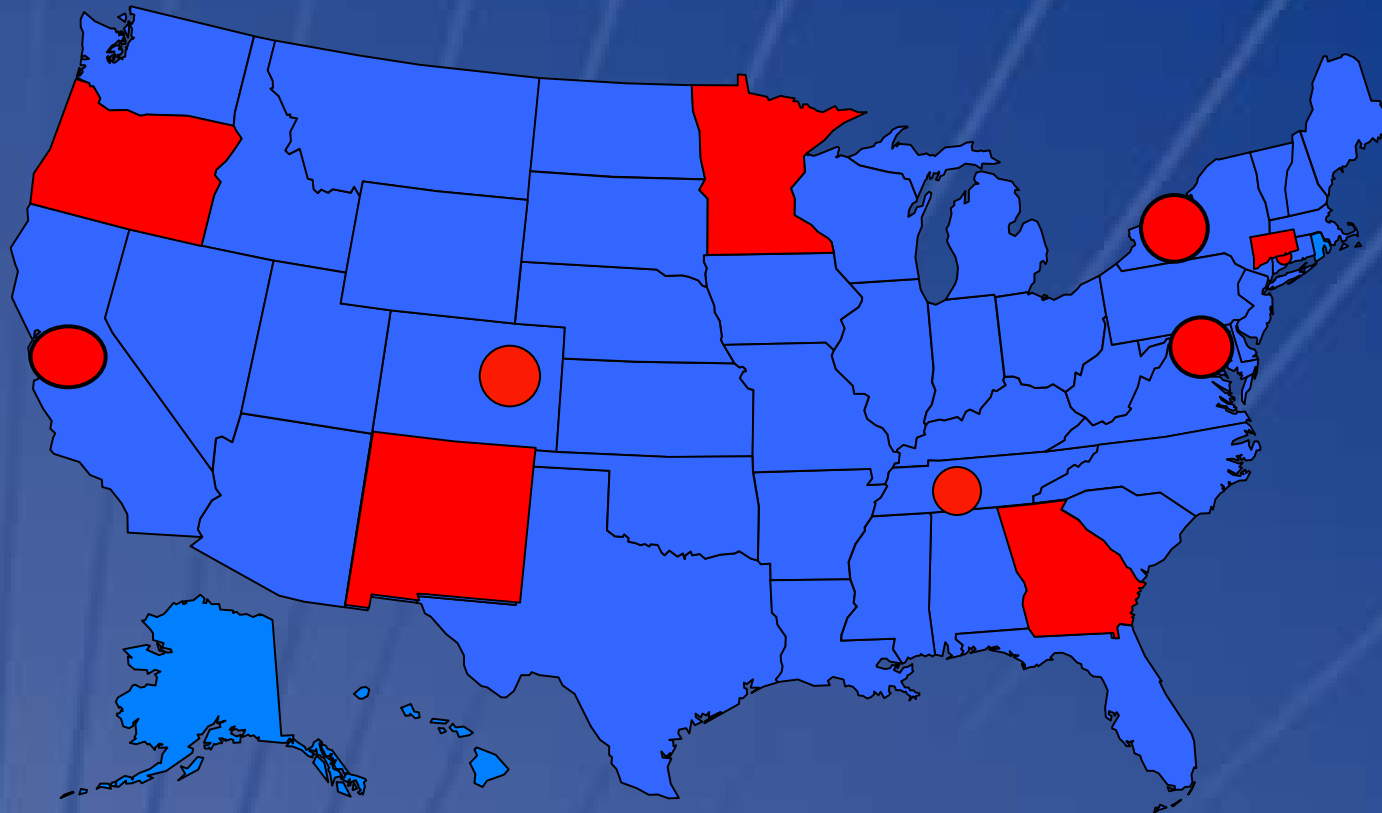
# National *Salmonella* Surveillance System - Summary

- *Salmonella* Enteritidis currently most reported *Salmonella* serotype
- Peaked in 1995, but still high with over 5,000 cases in 2007
- Spread quickly across the US starting in the northeastern states

# FoodNet

- Active surveillance for foodborne diseases in ten states
- Participate in conducting active surveillance, surveys, and epidemiologic studies
- Aim to gain better understanding of epidemiology of foodborne diseases

# FoodNet sites 1996-2007



15% of U.S. population

Year	Pop (millions)
1996	14.3
1997	16.1
1998	20.7
1999	25.9
2000	30.6
2001	34.9
2002	38.0
2003	41.9
2004	44.5
2005	44.9
2006	45.4
2007	45.9



# Relative rates of laboratory-diagnosed *Salmonella* Enteritidis cases, FoodNet sites, 1996 – 2008



# The surveillance pyramid

Reported  
↑  
Culture-confirmed case  
↑  
Lab tests for organism  
↑  
Specimen obtained  
↑  
Person seeks care  
↑  
Person becomes ill  
↑  
Population exposed



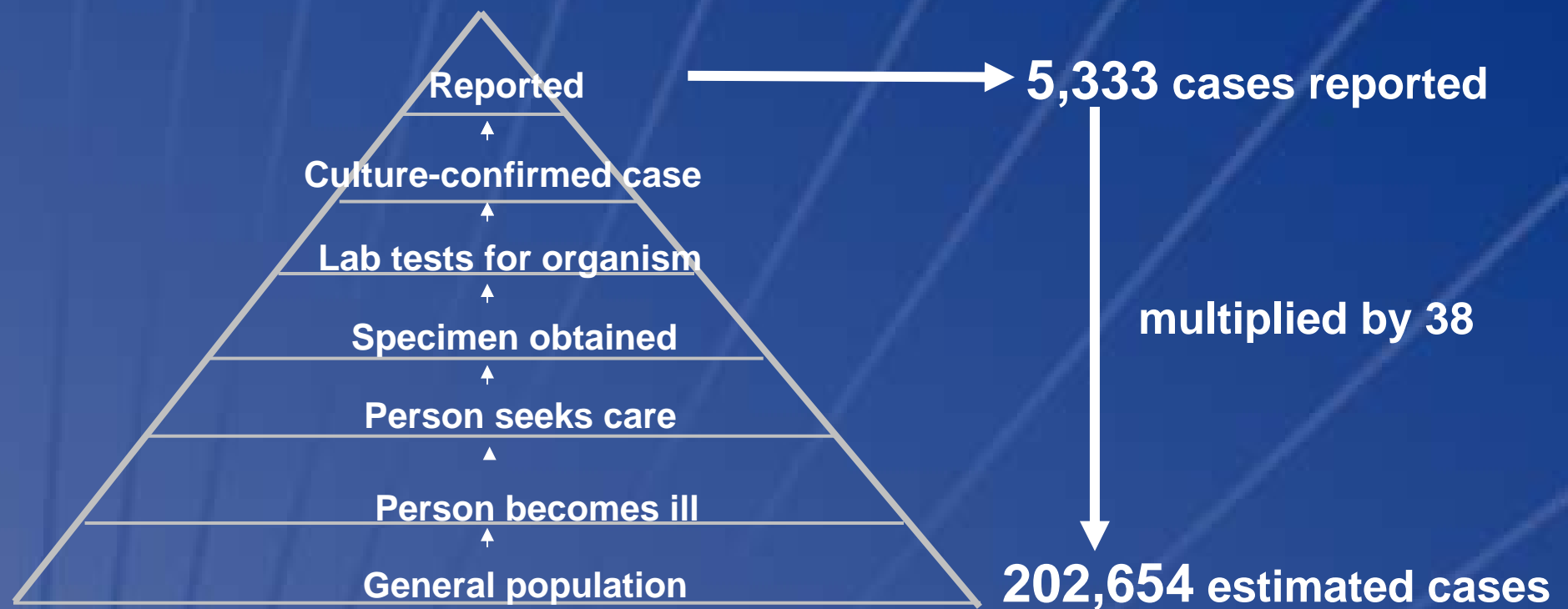
# FoodNet's contribution to the surveillance pyramid



# FoodNet's contribution to the surveillance pyramid

- Estimate that for every reported case of *Salmonella* Enteritidis, 37 cases go unreported
- Estimate that 16% of all *Salmonella* infections acquired outside the USA

# Estimate of SE infections, 2007



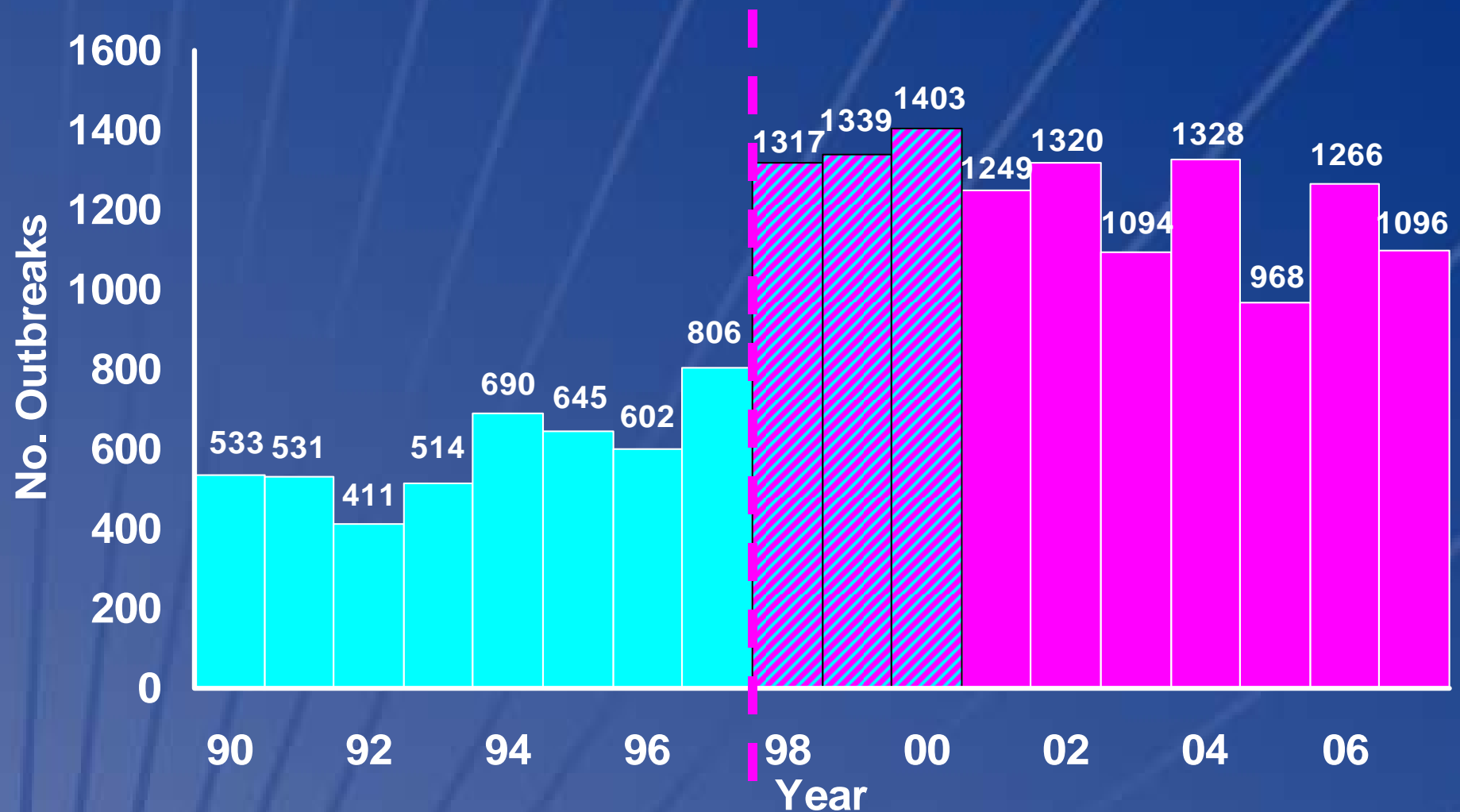
# FoodNet - Summary

- Relative rate of *Salmonella* Enteritidis infection is on the rise
- There are 38 times more infections than what is reported through passive surveillance systems
  - Therefore over 200,000 SE cases in 2007
- 16% of infections are acquired abroad

# Foodborne Disease Outbreak Surveillance System

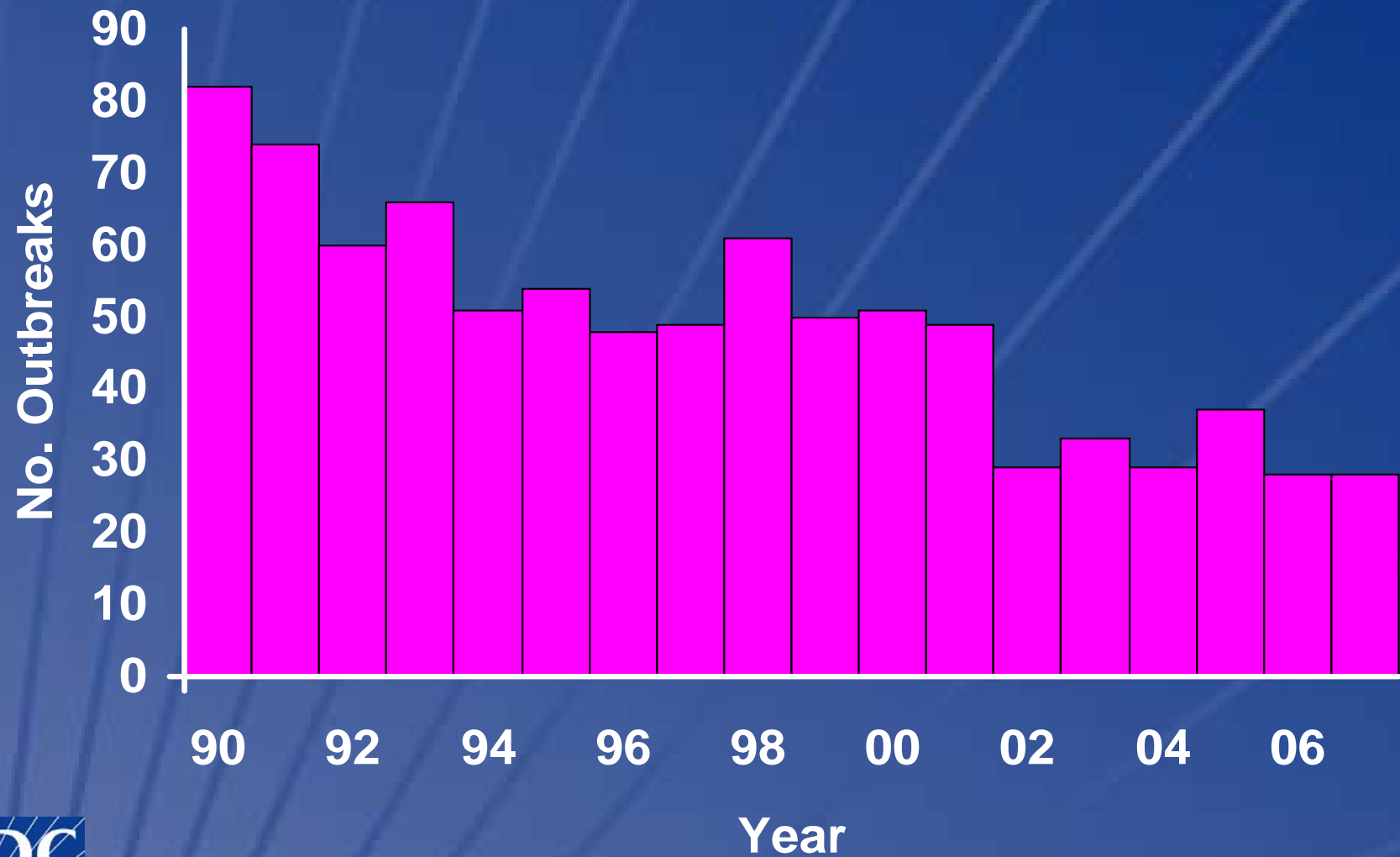
- State and local health departments investigate and report foodborne outbreaks to CDC
- Surveillance system started in 1973 and has been web-based since 1998
- Approximately 1,300 reports per year
- Data collected: number of cases, implicated food, pathogen, etc

# Foodborne disease outbreak reports 1990- 2007

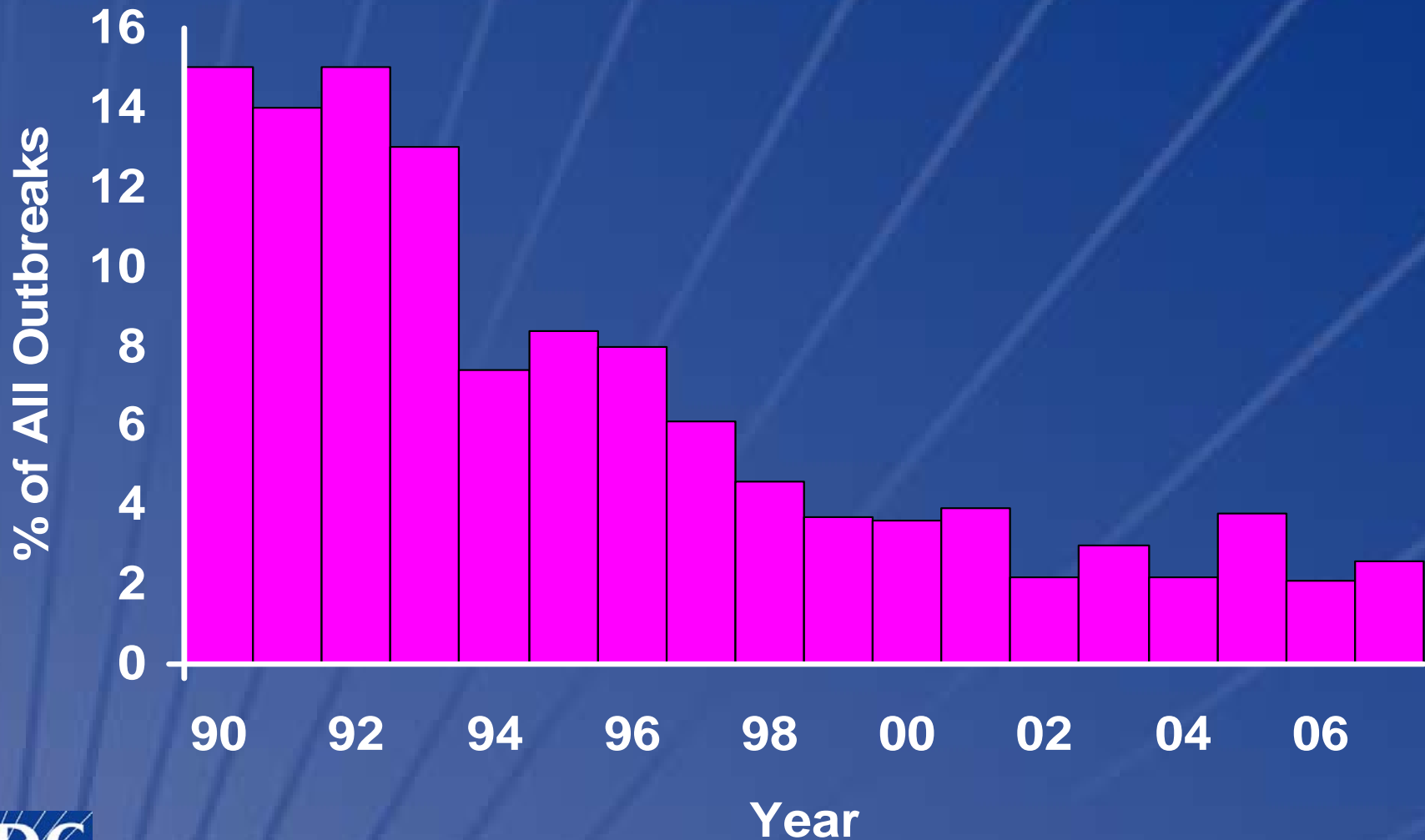




# Outbreaks due to *Salmonella* Enteritidis, 1990 - 2007



# Percentage of outbreaks due to *Salmonella* Enteritidis, 1990 - 2007



# Determining egg association in SE outbreaks

- All outbreaks investigated by state/local health departments to determine contaminated food vehicle
- All foods are considered regardless of etiology
- When traceback investigations are conclusive, SE of the same subtype is often identified on the farms of origin

# Attributing egg association to all cases

- Uncertainty in attributing proportion of cases in egg-associated outbreaks to:
  - Outbreaks with unknown food vehicle
    - Only ½ of outbreaks have vehicle identified
  - Non-outbreak associated cases
    - Majority of SE cases are not associated with an outbreak

# Egg-associated illnesses in SE outbreaks, 1985-2007

	Total	Vehicle determined	Egg status of food known	Egg Associated
Outbreaks	1,112	523	502	376
Illnesses	35,552	25,555	24,464	18,347

- High range estimate:  $18,347 / 24,464 = 75\%$
- Low range estimate:  $18,347 / 35,552 = 52\%$
- Mid range estimate:  $(75\% + 52\%) / 2 = 64\%$

# Foodborne Disease Outbreak Surveillance System - Summary

- Number of *Salmonella* Enteritidis outbreaks decreased early on but has leveled off
- 75% of SE outbreaks with known vehicle were due to eggs
- Mid-range estimate for all SE outbreaks due to eggs is 64%

# Estimated number of SE cases due to eggs in the United States, 2007

- Reported SE cases: 5,333
- FoodNet multiplier: 38
- Proportion acquired outside US: 16%
- Proportion due to eggs: 64%

# Estimated number of SE cases due to eggs in the United States, 2007

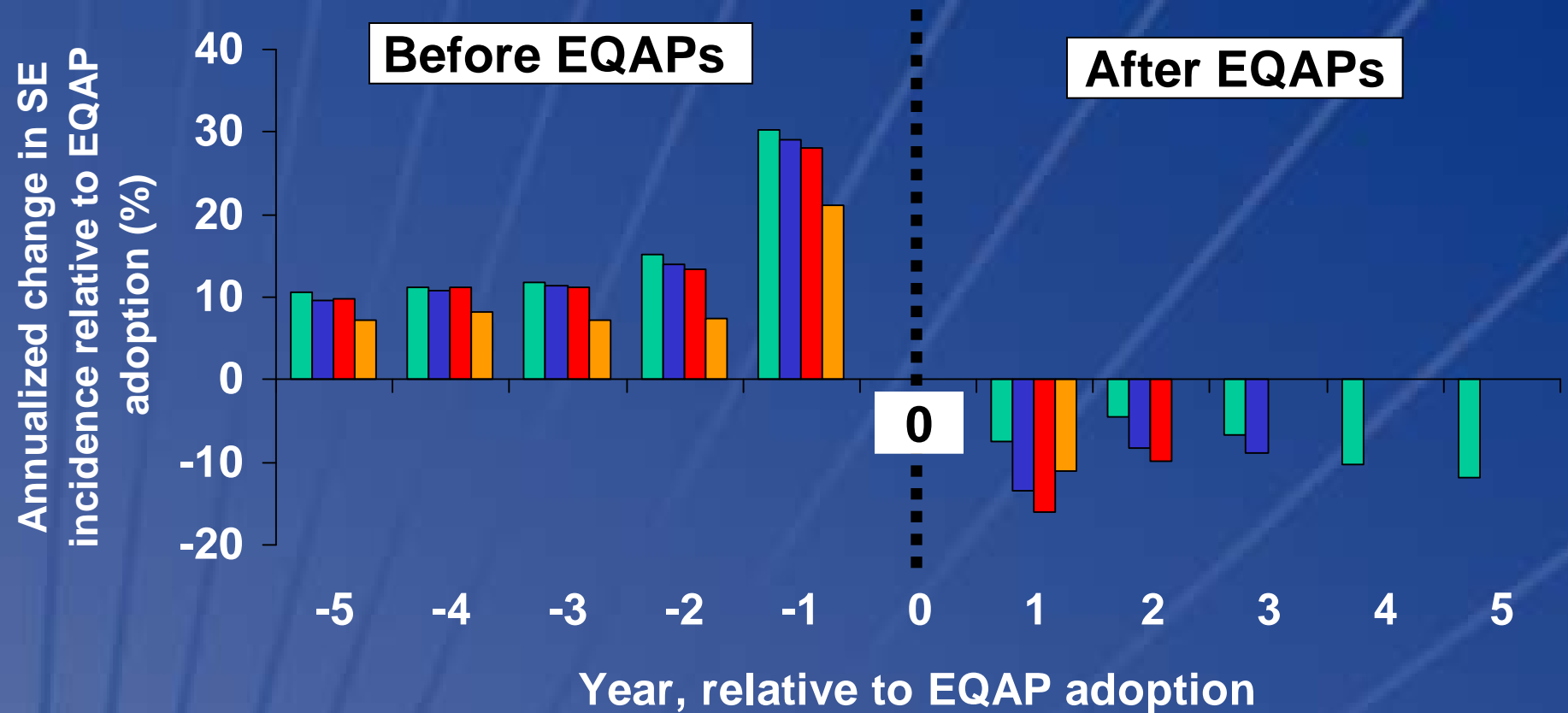
- $5,333 \times 38 = 202,654$  total cases of SE
- $202,654 - (0.16 \times 202,654) = 170,229$  cases of SE acquired in US
- $170,229 \times 0.64 = 108,947$  egg-associated cases
- Round to 109,000 egg-associated cases acquired in the USA in 2007



# Egg Quality Assurance Programs (EQAPs)

- Voluntary measures for minimizing contamination of eggs with *Salmonella* Enteritidis
- Follow Hazard Analysis Critical Control Point (HACCP) principles
- Designed around production, management, and monitoring practices
- Adopted in various states throughout 1990s

# Annualized change in incidence of SE in relation to adoption of EQAPs



States with five years of data (n=4)

States with three years of data (n=6)

States with two years of data (n=7)

States with one year of data (n=11)



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# Conclusions

- *Salmonella* Enteritidis estimated to cause more than 200,000 illnesses a year
- Eggs estimated to cause approximately 64% of these cases (ranging from 75% and 52%)
- Regulation of egg production has been linked with decreased SE incidence
- Control programs making progress, but need to be standardized and more widely adopted

# Acknowledgements

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